Ancient Mesoamerica, 3 (1992), 51-59

IDENTITY OF A NEW WORLD PSYCHOACTIVE TOAD

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Abstract

Anthropologists have long speculated that ancient peoples of Mesoamerica used a toad, *Bufo marinus*, as a ritual intoxicant. This hypothesis rests on many iconographic and mythological representations of toads and on a number of speculative ethnographic reports. We reject *B. marinus* as a candidate for such use because of the toxicity of its venom. A more likely candidate is the Sonoran desert toad, *Bufo alvarius*, which secretes large amounts of the potent, known hallucinogen, 5-methoxy-N,N-dimethyltryptamine (5-MeO-DMT). We demonstrate that the venom of *B. alvarius*, though known to be toxic when consumed orally, may be safely smoked and is powerfully psychoactive by that route of administration. These experiments are the first documentation of a hallucinogenic agent from the animal kingdom, and they provide clear evidence of a psychoactive toad that could have been employed by Precolumbian peoples of the New World.

For the last 30 years, native uses of psychoactive substances have been the focus of a great deal of scientific research. To date, more than 200 psychoactive plants have been identified worldwide, and their significance to indigenous cultures has been justly celebrated (Furst 1972a; Schultes and Farnsworth 1980; Schultes and Hofmann 1979). In many instances, however, ethnopharmacological research has lacked sufficient interdisciplinary perspective. Too often botanists and phytochemists lack the necessary ethnographic training, while anthropologists working in this field not infrequently promote biologically untenable hypotheses.

Perhaps no case better illustrates this shortcoming than the long-standing debate concerning the possible use of the marine toad, *Bufo marinus*, as a psychoactive drug by ancient civilizations of Mesoamerica. The importance of this controversy to anthropology is evident in an outpouring of academic literature (Coe 1971; Dobkin de Rios 1974; Furst 1972b, 1976; Hamblin 1979, 1984; Kennedy 1982). For ethnopharmacologists the discovery of a psychoactive toad would be astonishing, because it would be the first proven instance of the use of a hallucinogenic agent from the animal kingdom. To date, all known and deliberate human use of natural hallucinogens has involved derivatives of higher plants and fungi.[1]

The poisonous toad *Bufo marinus* is native to the New World, where it is a common denizen of low swampy habitats ranging from Florida, west along the Gulf Coast to Mexico, then south to Panama and northern South America. In Postcolumbian times, it dispersed rapidly throughout the Antilles and south along the Pacific coast of South America, as well as inland into the Amazon basin (Zug 1979). The large parotoid glands on the back of the toad have been described as "veritable chemical factories" (Kennedy 1982:284); they produce and secrete at least 26 compounds, all of which are biologically active. Some of these—the phenethylamine bases and their derivatives such as dopamine, epinephrine, and norepinephrine, as well as a number of indole derivatives like serotonin—are benign and occur naturally in human tissues.

However, the venom glands secrete other compounds of considerably greater interest, including bufotenine, a purported hallucinogenic agent (Fabing and Hawkins 1956), and two classes of toxic cardiac glycosides, bufogenin and its derivative bufotoxin (Daly and Witkop 1971; Deulofeu and Rúveda 1971; Meyer and Linde 1971). These compounds are found in the skin

[1]To be sure, there have been numerous reports of psychotomimetics derived from animals. Britton (1984) cites an obscure early nineteenth-century travel account from eastern Brazil that suggests that the Malalis Indians may have used *bichos de tacuara*, moth larvae, tentatively identified as *Myelobia smerintha*, as a hallucinogen. Hoffer and Osmond (1967) refer to a hallucinogenic fish, the Silver Drummer fish, found in the waters off Norfolk Island. Ichthyoallyeinotoxism, or hallucinogenic fish poisoning, has been reported from the tropical Pacific and Indian oceans (Halstead 1978; Helfrich and Banner 1960). Several species in two families have been implicated including two species of mullet, *Mugil cephalus* and *Neomyxus chaptalli*, and two species of goatfish, *Mulloidichthys samoensis* and *Upeneus arge* (Helfrich and Banner 1960).

The Brazilian report, though provocative, is based strictly on hearsay. No voucher specimens have verified the identity of the moth, no chemical analysis has been undertaken, and, in the original report, the correspondent did not observe anyone experiencing psychoactive effects (Saint-Hilaire 1824). In the case of the fish, the symptoms of the intoxication—dizziness, loss of equilibrium, partial paralysis of the legs, an itching or burning sensation in the throat, hallucinations and mental depression, delirium, a subjective perception of imminent death—appear to be highly unpleasant and difficult to distinguish from those that might be caused by poisoning. The chemistry and pharmacology of the phenomenon remain unknown and attempts to replicate the intoxication in controlled experiments have failed (Halstead 1978; Helfrich and Banner 1960). From the isolated reports, it appears that the biointoxication is sporadic and unpredictable in its occurrence. Evidently those who have experienced hallucinogenic fish poisoning have done so quite inadvertently, while seeking out fish that under most circumstances are perfectly edible.

and glands of a number of toads, including the common European species *Bufo vulgaris* (Wieland and Alles 1922), and it is their properties that have earned these animals a notorious place in the repertoires of poisoners and black magicians throughout the world.

As early as Roman times Juvenal (fl. A.D. 100–128) described women using toads (presumably *Bufo vulgaris*) to kill unsuspecting husbands (Chen and Jensen 1929). The toxicity of the venom provided the basis upon which the Talmud differentiated between frogs and toads, classifying the latter with all animals that were poisonous to the touch – an idea that persists to this day in Western societies (Abel and Macht 1911). Soldiers in the Middle Ages believed that a discrete way of killing an enemy was to rub his skin or wounds with the secretions of *Bufo vulgaris*.

Bufo marinus reached Europe very soon after the voyages of Columbus, and poisoners quickly discovered that by placing the toad in boiling olive oil, they could skim the secretions of the glands off the surface (Holmstedt, personal communication 1982). In early sixteenth-century Italy, poisoners devised sophisticated processes for extracting toad toxins in salt, which could then be sprinkled on an intended victim's food (Lewin 1920). So highly regarded was the toxicity of toad venom that at the beginning of the eighteenth century it was added to explosive shells and mixed with saltpeter to make gunpowder (Chen and Jensen 1929; Chilton et al. 1979). Presumably, the military commanders believed that if the cannon did not kill their enemies, the toad toxins would.

European physicians incorporated toad venom into their *materia medica* at a very early point. Dried and powdered toad held a prominent place as a treatment for dropsy, fever, and a number of other ailments in numerous important pharmacopoeias. Toads remained a prominent therapeutic agent throughout the eighteenth century and as late as 1833 were mentioned in a medical compilation, *Pharmacologia*, written by J. A. Paris (Abel and Macht 1911).

Chinese physicians were even more inventive than their Western counterparts in the use of toad venom. For centuries they had formed the toxic secretions into smooth disks named *ch'an su* ("toad venom" in Mandarin). According to the *Pentsao Kang Mu*, a famous herbal guide written at the end of the sixteenth century, this preparation was used to treat toothache, canker sores, sinusitis, and bleeding gums. Taken orally, it was said to cure the common cold (Chen and Jensen 1929).

From this list of rather mundane afflictions, it may not be apparent that the Chinese were, in fact, using an extremely toxic preparation. Although early medical reports are uncertain as to the species of toad (Tu et al. 1923; Peng et al. 1921; Chen and Jensen 1929), analysis of *ch'an su* (probably *Bufo gargarizans*) revealed the presence of both bufogenin and bufotoxin (Chen and Jensen 1929; Deulofeu and Rúveda 1971; Lutz 1971). Separate studies suggested that *ch'an su* was 50 to 100 times more potent than digitalis, a powerful cardiotonic derived from the common European foxglove (*Digitalis purpurea*), which had been used as a heart stimulant in Britain since the tenth century (Chen and Jensen 1929).

In one experiment a cat was injected with as little as 0.02 g of crude toad venom; its blood pressure tripled almost immediately, and it collapsed following massive heart failure (Abel and Macht 1911). This could mean that as little as half a gram of dried venom, injected intravenously, would do similar damage to a 150-lb. human.

The argument in favor of the toad as hallucinogen has rested until now on several lines of evidence. First, throughout Central America the toad was a prominent symbol, particularly in Olmec, Mayan, and Aztec iconography (Furst 1972b, 1976; Kennedy 1982; Tozzer and Allen 1910). Numerous artifacts, including small ceramic serving bowls, have obvious toad representations with especially graphic portrayals of the distinctive parotoid glands (Furst 1972b; Dobkin de Rios 1974; Kennedy 1982). Second, at a number of Classic, Late Classic, and Postclassic Maya sites *Bufo marinus* bones dominate the amphibian component of the faunal remains and have been often found in ritual context (Hamblin 1979, 1984; Olsen 1972, 1978; Pollack and Ray 1957; Wing and Steadman 1980). The concentration and distribution of *B. marinus* remains at San Lorenzo led one prominent archaeologist to suggest that the Olmec civilization may have used the toad as a narcotic (Coe 1971). Third, one of the substances secreted by the toad is 5-hydroxy-N,N-dimethyltryptamine (5-OH-DMT), or bufotenine, a compound also found in a hallucinogenic snuff made today by South American Indians from the seeds of *Anadenanthera peregrina*. This arborescent member of the Leguminosae occurs in the plains and grasslands of the Orinoco basin of Colombia and Venezuela, in light forests in southern Guiana, and in the Río Branco area of northern Amazonian Brazil (Schultes and Hofmann 1980). The snuff, known vernacularly as *yopo*, is used by the Saliva of the middle Orinoco, the Guahibo of the Venezuelan savanna, the Achagua of the Colombian Caqueta, and other indigenous groups (Altschul 1972). One report in the medical literature suggests that pure bufotenine, injected intravenously into human subjects, induces hallucinations (Fabing and Hawkins 1956). Finally, the proponents of the hallucinogen hypothesis all cite an unpublished report of the contemporary use of *Bufo marinus* in a hallucinogenic preparation in Vera Cruz, Mexico (Knab, cited in Furst 1974; Kennedy 1982).

This cumulative evidence is far from conclusive. Even accepting that Mayan iconography represents *Bufo marinus*, one may not conclude, ipso facto, that the Maya used the toad as a hallucinogen. Symbols, in particular ritual symbols, incorporate a wide range of meanings. Moreover, they are not necessarily diachronically stable. Kennedy (1982) points out the remarkable fecundity of the toad. One could speculate with equal assurance that the toad motifs relate to fertility, to water or rain, or even, given the life cycle of the creature, to some notion of sacred metamorphosis and renewal.

By the same token, it is not always possible to draw a direct relationship between a decorative motif applied to ceramic wares and a purported use of the depicted object itself. Hellmuth (1974:156) has noted that in the central market in Guatemala City, native women today sell a great variety of modern toad-shaped artifacts; does this imply, he asks rhetorically, that "these little old ladies secretly imbibe mind expanding doses of toad-juice cocktails under their counters?" Certain investigators (Schultes and Bright 1979; Schultes and Hofmann 1980; Sharon 1978) have drawn conclusions from the provocative shapes and motifs of archaeological artifacts, but they have only done so when the purported ancient use of a hallucinogen is corroborated by ethnohistorical records or ethnographic evidence of contemporary use.

The paucity of historical evidence is another flaw in the argument for hallucinogenic use of toads. If, in fact, the extensive iconographic representation of *Bufo marinus* indicates its

role as a drug in state religion, one would expect to encounter some record of its use in the early chronicles. Dobkin de Rios (1974) speculates that the absence of ethnohistorical documentation is due to the fact that drug use by the general population was suppressed by the Maya political and religious hierarchy and, in turn, concealed from the Spanish. Yet it was precisely the "diabolical" use of hallucinogens, along with other indigenous religious practices, that the Spanish so zealously ferreted out and described in detail in their writings, if only as a way of rationalizing their own nefarious actions. They left us extensive accounts of virtually all of the major hallucinogenic plants now known to have been used in the territories they conquered (Schleiffer 1973).

Furthermore, although it is true that the Spanish tried to suppress the use of psychotropic drugs throughout the Americas, they mostly succeeded in driving these practices underground. In many cases, it is possible to demonstrate the continuity and subsequent modifications of Precolumbian practices through colonial times to the present (Davis 1983; Furst 1972a; Schultes and Hofmann 1980; Sharon 1978). What, one is forced to ask, happened to *Bufo*?

At least one ethnohistoric source does mention the use of a toad in a folk preparation. Furst (1974:154) notes that the "17th century English friar, Thomas Gage, described the Pokoman Maya practice of steeping venomous toads in fermented beverages used for ritual intoxication to give them extra potency." The original source, however, is somewhat less precise. It speaks of a *chicha* consisting of water, honey or sugar cane, tobacco leaves, various roots "which they know to be strong in action," and, in certain localities, a live toad. This mixture was placed in a sealed container "till all that they have put in be thoroughly steeped, the toad consumed, and the drink well strengthened" (Thompson 1970:120). From the original syntax it is not clear whether the Pokoman Maya attributed the potency of the preparation to the addition of the unidentified toads, the plant constituents, or the month of underground fermentation. The practice of steeping toads in *chicha* to make a more potent beverage continues to this day and has been reported from the Quiche Maya (Furst 1972b), but there is no evidence that a hallucinogenic preparation is the result. Similarly there is no indication in the journals of Thomas Gage that the fermented potions of the Pokoman Maya were hallucinogenic. They were, evidently, highly poisonous and "certainly the cause of many Indians' death, especially where they use the toad's poison with it" (Thompson 1958:225).

The ethnographic literature is somewhat more promising. Furst (1974) cites a paper by Carneiro (1970) suggesting that the Amahuaca Indians of Peru introduce frog or toad venom into self-inflicted skin burns so as to induce a trance state. Similar practices have been observed among the Cashinahua and among various indigenous groups of the Guyanas (Furst 1972b). Unfortunately, neither Carneiro nor Furst is able to identify the animal in question, and all observers report that the Amahuaca and other peoples combine their use of toads with ingestion of *ayahuasca* (*Banisteriopsis caapi*), a well-known and powerful plant hallucinogen (Furst 1972b).

Those who suggest that toads were used as drugs also draw attention to the distribution of *Bufo marinus* remains at a number of archaeological sites (Coe 1971; Hamblin 1979, 1984; Olsen 1972, 1978; Pollock and Ray 1957; Wing and Scudder 1991; Wing and Steadman 1980). Coe (1971:74) noted in discussing the osteological remains at San Lorenzo: "These toads are a puzzle, as they cannot be skinned without an extremely dangerous poison getting into the meat. We are now looking at the possibility that the Olmecs used them for a hallucinogenic substance called bufotenine, which is one of the active ingredients." As it turns out, a survey of the archaeological literature shows that a significant quantity of *Bufo marinus* remains have been found in middens throughout Central America, leading other archaeologists to believe that Precolumbian Indians used the toad for meat after carefully cutting away the skin and parotoid glands (Cooke 1979, 1981). In spite of Coe's cautionary words, Cooke (1979) butchered and cooked several specimens, which he noted tasted rather like smoked chicken. Based on the temporal and spatial distribution of *Bufo marinus* remains, he proposed that the toad was not used as a drug, but as a survival food, a suggestion partially corroborated by the fact that it is today employed for precisely that purpose by the Campa Indians of the lower Apurimac River in Peru (Weiss, personal communication 1981).

The central weakness of the hallucinogen hypothesis is the inability of proponents to demonstrate how any preparation of *Bufo marinus* can be safely consumed. It is true that the glands secrete bufotenine, a methylated derivative of serotonin and a known constituent of certain South American hallucinogenic snuffs (Schultes and Hofmann 1980). However, also present in the toad venom are the extremely powerful cardiac glycosides, bufotoxin and bufogenin (Meyer and Linde 1971). Both are highly toxic. Mere topical exposure to the crude venom (handling toads) may result in severe headache, nausea, and violent vomiting (Allen and Neill 1956). A recent attempt on the part of a young man to experience hallucinogenic effects from the venom resulted in his suffering near-lethal seizures (Pulling 1990). This victim had taken the venom orally by touching the glands and then licking his fingers. It is likely that ingesting a straight maceration of the parotoid glands would cause cardiac failure long before the recipient would get a chance to experience any useful states of consciousness induced by bufotenine (Alger 1974). It seems unlikely that the Maya would have been interested in poisoning vast numbers of their priests, who presumably would have been the ones taking the drug. Only if some process had been developed that selectively neutralized the toxic constituents could *Bufo marinus* have been made into an orally administered hallucinogen. Folk healers have often demonstrated a sophisticated biological and chemical knowledge, as is evident in their ability to enhance certain hallucinogenic preparations by the careful use of various admixtures (Schultes and Hofmann 1980). However, the task of eliminating both bufotoxin and bufogenin from an oral toad preparation would be formidable.

Kennedy (1982) won a prize for best paper in art and intellectual history with her wild suggestion that the Maya used ducks as bioprocessors of the toxins. In her scheme, the Maya raised toads on a large scale, fed the toads to ducks, and then ritually consumed the birds' flesh, which she thought would now be safely psychoactive. She demonstrated that ducks could safely eat toads, but she failed to take the obvious next step of butchering the birds and assaying their meat. That such a hypothesis was seriously entertained, and even rewarded by a prize committee, reveals a remarkable willingness to indulge in sheer fantasy ungrounded in biological reality.

A more promising attempt was made by Timothy Knab, who

searched the backcountry of Mexico for evidence of a contemporary *curandero* who might have preserved ancient knowledge of a toad preparation. It is Knab's unpublished account that is heralded by Kennedy. "Knab," she writes, "has penetrated the arcana of several curanderos in the Veracruz area and details the recipe for the preparation of *B. marinus* paratoid [sic] glands which eliminates the most toxic compounds" (Kennedy 1982: 285).

After considerable effort, Knab located an old *curandero* in the mountains of southern Veracruz who claimed to know the formula of a preparation that had not actually been used by his people in 50 years. The old man ground the glands of 10 toads into a thick paste, to which he added lime water and the ashes of certain plants. The mixture was boiled all night, or until it no longer smelled foul, and then was added to corn beer and filtered through palm fiber. The liquid was mixed with cornmeal and placed in the sun for several days to ferment. Finally the mixture was heated to evaporate the remaining fluid, and the resulting hardened dough was stored until the time came to mix it with water to produce the final potion.

Although Knab had persuaded the *curandero* to prepare the drink, under absolutely no conditions would the old man sample it. Only very reluctantly did he consent to give a dose to Knab. Knab's intoxication was marked by sensations of fire and heat, convulsive muscle spasms, a pounding headache, and delirium. He writes of the experience:

> The drink starts to take effect within a half hour; profuse sweating is noted along with a sudden increase in heart beat. The heart beat becomes continuously harder and stronger. A pronounced chill sets in with twitching of the facial and eye muscles. A pounding headache and delirium shortly follow the onset of twitching. During this delirium, the individual is unable to walk, sit up, or move about, as he lies in a specially excavated depression in front of the fire. This state usually lasts from three to five hours and wears off slowly. (Knab 1974)

Knab reports no hallucinations, and from his subjective description it appears that he merely suffered the symptoms of severe poisoning (Knab, personal communication 1982). He never found out whether the preparation neutralized any of the toxic compounds, for it was never analyzed.

The principal unresolved issue in this controversy is the questionable pharmacological activity of bufotenine. On this point anthropological speculations have, in some instances, been confused and poorly informed. When Dobkin de Rios asserts that "bufotenine is a hallucinogenic drug which has dangerous cardiovascular effects in man and is usable only in low dosages" (1974:148–149), she not only ignores pharmacological evidence (Holmstedt and Lindgren 1967; Turner and Merlis 1959), but also appears to be confusing the physiological effects of the cardioactive steroids in the venom with the purported activity of bufotenine on the central nervous system. When La Barre (1970:146) refers to bufotenine as "a violently hallucinogenic drug," he mistakenly attributes the psychoactivity of the South American vegetable snuffs to bufotenine (5-OH-DMT), when it had already been well established that the compound responsible was not bufotenine but rather 5-MeO-DMT (Holmstedt and Lindgren 1967).

Virtually every report that characterizes bufotenine as a psychotomimetic dates to a single experiment completed by a medical doctor, Howard Fabing, in the 1950s. Fabing obtained permission to inject bufotenine intravenously into a number of inmates at the Ohio State Penitentiary. The recipient of the mildest dose complained of nausea, prickling sensations in the face, and slight difficulty in breathing. With higher dosage these symptoms became more pronounced and the subject's face and lips became purplish. The final dose caused mild hallucinations and delirium, and the skin turned "the colour of an eggplant." The hallucinations were ephemeral. Three minutes after injection, the subject vomited and "saw red spots passing before his eyes and red-purple spots on the floor. Within two minutes, these visual phenomena were gone, but they were replaced by a yellow lens filter" (Fabing and Hawkins 1956:887). That is the extent of the hallucinations experienced by any of the recipients of the bufotenine injections.

Later investigators attempted but failed to replicate these results. Harris Isbell, a researcher at the Public Health Service Hospital in Lexington, Kentucky, experimented with bufotenine as a snuff. Neither inhalation of pure bufotenine in aerosol suspension, or oral ingestion of bufotenine in doses as high as 100 mg elicited any psychoactive effect (Holmstedt and Lindgren 1967). Turner and Merlis (1959) tried injecting bufotenine intramuscularly. They noted that with a dose of 40 mg, the recipient "suddenly developed an extremely rapid heart rate; no pulse could be obtained; no blood pressure measured . . . onset of auricular fibrillation . . . extreme cyanosis developed" (Chilton et al. 1979:64). Massive resuscitative procedures were immediately implemented, and fortunately the pulse eventually returned to normal (Chilton et al. 1979). After the failure of this and other experiments, the investigators concluded that "we must reject bufotenine as capable of producing the acute phase of cohoba (*Anadenanthera peregrina*) intoxication" (Chilton et al. 1979:64).

This conclusion is supported by other experimental evidence. One measure of the ability of compounds to penetrate the nervous system is the lipid solubility. Gessner and Page (1962) showed that bufotenine has a very low lipid solubility and is relatively incapable of crossing the blood-brain barrier, making it unlikely that the drug would have any effect on the central nervous system. Therefore, even assuming that a folk preparation could eliminate the toxic constituents in *Bufo marinus* venom, it is very doubtful that bufotenine itself is hallucinogenic.

While we do not presume to be authorities in Mesoamerican history and archaeology, our ethnopharmacological experience leaves us somewhat surprised that, given the intensity of this debate, none of the participants, with the exception of Furst (1972b), has noted that there exists a much better candidate than *Bufo marinus* as a possible amphibian source of an ancient hallucinogen. Anthropologists will be interested to know that a close relative of the marine toad is even today used for psychoactive effect by human beings.

Bufo alvarius, the Sonoran Desert toad (formerly known as the Colorado River toad), is an amphibian found only in the Sonoran Desert, an area of approximately 120,000 square miles that reaches from southeastern California across the southern half of Arizona and south approximately 400 miles into Mexico. Nocturnal in habit, the toad avoids the searing desert heat by burrowing beneath the ground during the day, emerging at dusk to congregate around streams, springs, and moist river beds. For most of the year, from September through April, the toad remains underground in a dormant state. Beginning in

June, before the summer rains begin, it is highly active, and the desert comes alive with thousands of the animals (Stebbins 1966; Wright and Wright 1949).

One of more than 200 species of *Bufo*, the Sonoran toad is a large amphibian, and like *B. marinus* it has prominent parotoid glands that secrete a viscous milky-white venom. The two species are morphologically similar (Figure 1) and iconographic representations would be impossible to distinguish. The secretions of *B. alvarius*, however, are very different from those of its better-known relative. Toad venom is biochemically complex, with particular combinations of constituents peculiar to each species, a sort of biochemical "fingerprint" useful for taxonomic delineation. *Bufo alvarius* is unique within the genus in its possession of an unusual enzyme, O-methyl transferase, which, among other reactions, converts 5-OH-DMT to the potent hallucinogen 5-MeO-DMT. In fact, the activity of this enzyme leads to the production and accumulation of enormous amounts of 5-MeO-DMT, up to as much as 15% of the dry weight of the parotoid and tibial glands (Erspamer et al. 1965, 1967; Cei et al. 1972).

One of the most powerful hallucinogens known from nature, 5-MeO-DMT accounts for much of the psychoactivity of South American snuffs derived from *Anadenanthera peregrina* as well as those derived from various species of *Virola*, a genus of trees in the nutmeg family (Schultes and Hofmann 1980; Holmstedt and Lindgren 1967). In the plant kingdom it usually occurs together with N,N-dimethyltryptamine (DMT), another strong drug. Orally inactive due to the activity of an enzyme in the human gut (monoamine oxidase), these compounds are usually smoked and rarely injected. They may be ingested orally if taken in combination with monoamine oxidase inhibitors, as in the case of certain sophisticated indigenous preparations reported from the northwest Amazon (McKenna et al. 1984a, 1984b). Both DMT and 5-MeO-DMT are easily synthesized compounds that appeared as recreational psychedelics in the American drug subculture during the 1960s. DMT is a controlled substance under federal law, but its 5-methoxy derivative is not. Some chemical supply houses sell 5-MeO-DMT, and supplies are occasionally diverted to human users.

The disparity in the law probably has to do with the different reputations of these two drugs. When smoked, DMT produces a very rapid, intense intoxication of short duration that is marked by vivid visual imagery. These effects made it popular among users of LSD, psilocybin, and other well-known psychedelic drugs, and thus drew the attention of authorities. By contrast, smoking of pure 5-MeO-DMT, a more potent tryptamine, produces an overwhelmingly powerful experience that can be unnerving. One user describes inhaling 5-MeO-DMT vapor as "a rocket ship into the Void." Another comments: "If most hallucinogens, including LSD, merely distort reality, however bizarrely, 5-MeO-DMT completely dissolves reality as we know it, leaving neither hallucinations nor anyone to watch them. The experience need not be negative, but it is not for the novice" (anonymous, personal communication, April 11, 1987). As a result, 5-MeO-DMT never gained the street popularity or notoriety of its chemical cousin. Over the years it has remained an obscure drug taken mostly by small groups of psychiatrists and explorers of consciousness.

The first published analysis of the venom of *B. alvarius* appeared in 1965 and a more comprehensive study came out in a journal of pharmacology in 1967 (Erspamer et al. 1965, 1967). The research was later reported in a book on the evolution of the genus *Bufo* (Blair 1972). These publications probably inspired experimentation with the venom of *B. alvarius* that led to the appearance in 1984 of an underground pamphlet titled "*Bufo alvarius*, the Psychedelic Toad of the Sonoran Desert" (Most 1984). This pamphlet gave detailed instructions for collecting and drying the venom:

> Fresh venom can easily be collected without harm to the toad. Use a flat glass plate or any other smooth, nonporous surface at least 12-inches square. Hold the toad in front of the plate, which is fixed in a vertical position. In this manner, the venom can be collected on the glass plate, free of dirt and liquid released when the toad is handled.
>
> When you are ready to begin, hold the toad firmly with one hand and, with the thumb and forefinger of your other hand, squeeze near the base of the gland until the venom squirts out of the pores and onto the glass plate. Use this method to systematically collect the venom from each of the toad's granular glands: those on the forearm, those on the tibia and femur of the hind leg, and, of course, the parotoids on the neck. Each gland can be squeezed a second time for an additional yield of venom if you allow the toad a one-hour rest period. After this the glands are empty and require four to six weeks for regeneration.
>
> The venom is viscous and milky-white in color when first squeezed from the glands. It begins to dry within minutes and acquires the color and texture of rubber cement. Scrape the venom from the glass plate, dry it thoroughly, and store it in an airtight container until you are ready to smoke it. (Most 1984:10–12)

These instructions are remarkable in view of the known toxicity of the Sonoran Desert toad (Allen and Neill 1956). There

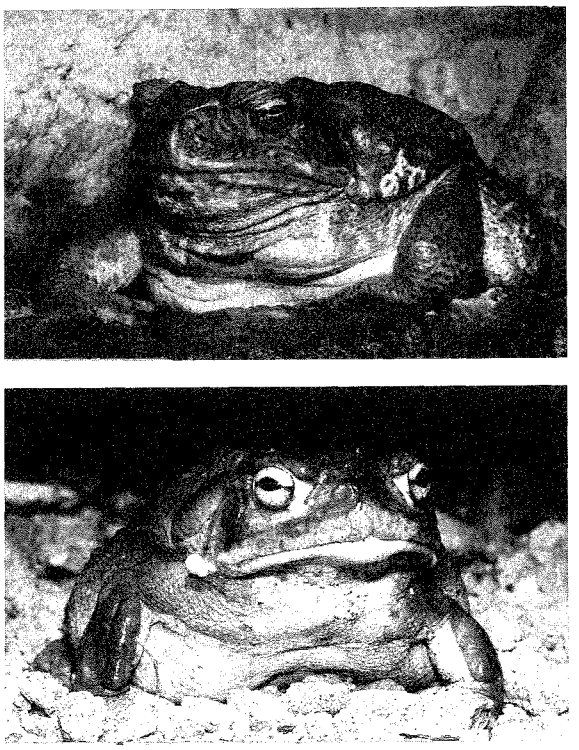

Figure 1. *Bufo marinus* (A) and *Bufo alvarius* (B). Photo by Al Morgan.

are many instances, for example, of dogs being poisoned after mouthing the animal. In one case an owner reported that he was able to remove the toad from his dog's mouth within 10 seconds. Nevertheless, after 30 minutes, the dog began to salivate profusely, quickly went into convulsions, and died, apparently in respiratory arrest. Human morbidity has also been reported. In 1986 a five-year-old boy with profuse salivation and continuous seizures was admitted to a hospital in southern Arizona; the seizure activity had begun within 15 minutes of his licking a toad, later identified as *Bufo alvarius*. The child survived, but it took a full week for him to return to normal (Hitt and Ettinger 1986).

Since 1987 Andrew T. Weil has interviewed a number of informants in southern Arizona who claim to have safely smoked toad venom and experienced positive psychoactive effects. No one reported toxicity. Based on these interviews, we hypothesized that smoking selectively denatures the toxic constituents. Therefore we felt confident in initiating a series of self-experiments with venom obtained from the parotoid glands of Sonoran Desert toads collected in Pima County, Arizona. The results of these experiments are noteworthy.

Both of us had previously smoked synthetic 5-MeO-DMT and were familiar with its effects. When we burned the venom we found the odor and taste of the smoke to resemble closely the very distinctive odor and taste of the vapor of the pure compound. We prepared for administration a small chip of dried venom, the size of a paper match head. Within 15 seconds of a single deep inhalation of the vaporized material, both of us experienced pronounced psychoactive effects. We recorded our impressions as follows:

> In comparison to the pure compound the toad venom appears longer lasting and, because one does not completely lose contact with reality, far more pleasant, even sensual. Shortly after inhalation I experienced warm flushing sensations, a sense of wonder and well-being, strong auditory hallucinations, which included an insect-cicada sound that ran across my mind and seemed to link my body to the earth. Though I was indoors, there was a sense of the feel of the earth, the dry desert soil passing through my fingers, the stars at midday, the scent of cactus and sage, the feel of dry leaves through hands. Strong visual hallucinations in orblike brilliance, diamond patterns that undulated across my visual field. The experience was in every sense pleasant, with no disturbing physical symptoms, no nausea, perhaps a slight sense of increased heart rate. Warm waves coursed up and down my body. The effects lasted only a few minutes but a pleasant afterglow continued for almost an hour. (Wade Davis, personal observation, January 12, 1991)

> Profound alteration of consciousness within a few seconds of exhaling. I relax into a deep, peaceful interior awareness. There is nothing scary about the effects and no sense of toxicity. I try to describe my feelings but am unable to talk for the first five minutes and then only with some difficulty. This is a powerful psychoactive drug, one that I think would appeal to most people who like the effects of hallucinogens. For the next hour I feel slow and velvety, with a slight pressure in my head. No long-lasting effects to report. (Andrew T. Weil, personal observation, January 12, 1991)

We repeated the experiment with a sample of venom collected two years earlier in Gila County, Arizona. This material had been kept in a closed vial at room temperature. It had darkened over time but was quite active.

The proof of the existence of a powerful psychoactive drug, easily obtained from a common and conspicuous toad forces us to reconsider some of the issues raised in the anthropological literature. One question demands consideration. Given that the toxic constituents of *B. alvarius* are evidently denatured by smoking, is it possible that *B. marinus* might also be benignly hallucinogenic if smoked or administered by some other means? Due to the presence of bufogenin and bufotoxin, Peter de Smet rejects the possibility that the Maya administered the venom as a hallucinogenic enema (de Smet 1985, personal communication 1981). Because of the toxicity of *B. marinus* venom, we considered it prudent not to experiment with smoking and elected to heed the advice of Furst who noted that "to experiment with these dangerous substances would obviously be the height of folly" (1976:165). However, the fact that analysis of the venom has yielded no hallucinogenic constituents suggests that it is highly unlikely that *Bufo marinus* could, under any circumstances now or in the past, be employed as a psychoactive agent. If the ancient civilizations of Mesoamerica did, indeed, have a toad-based hallucinogen, it would have had to come from *Bufo alvarius*.

Indigenous peoples of the Sonoran Desert would have certainly recognized the toxicity of this species. It has no predators and poisons dogs. We also know that these properties would not have deterred experimentation; on the contrary, they would have drawn attention to the toad. The record of folk experimentation suggests that Amerindian peoples consistently underwent considerable risk, marked no doubt by the occasional deaths of individuals, in their search for pharmacologically active substances. Some of the psychoactive plants, employed ritually now or in the past, are highly toxic. The ingestion of datura (*Datura* spp. and *Brugmansia* spp.) induces psychotic delirium marked by violent visions and burning thirst, with the possibility of stupor and death. The use of mescal bean (*Sophora secundiflora*), prominent in the Great Plains before the arrival of the peyote cult, was a pharmacological equivalent of Russian roulette.

Furst (1972b:45) has written,

> The area to which *Bufo alvarius* is presently native was once inhabited by archaic desert cultures; it is also the putative homeland of the Uto-Aztecans, from which they expanded southward into Mexico as early as 1500 B.C. Was it the shamans of the pre-agricultural desert cultures who discovered the potent psychotomimetic effects of toad poison and whose ecstatic trance experiences gave rise to the now widespread beliefs in the toad as a transforming shamaness . . . ?

At the time, Furst thought that Indians would have to ingest the toxin of *B. alvarius* by steeping the toad in some sort of potion. He did not know that taken alone 5-MeO-DMT is orally inactive, or that the venom could be collected, dried, and smoked (Furst, personal communication 1991). In fact, smoking was well known throughout the Americas and was intimately associated with ritual activities. Many Indians regarded smoke as sacred essence, a vehicle to the spirit world. The use of tobacco established a pattern of consuming psychoactive drugs by smoking. Admixtures to tobacco preparations abound (Wilbert 1987), and it is at least conceivable that toad venom would have been among them.

Extensive trade routes through the Sonoran Desert to Mesoamerica have been well documented (DiPeso 1974). Dried *B. alvarius* venom would have been an excellent object of trade.

It is an axiom of long-distance commerce that the ideal trade item is one that is highly esteemed, easy to transport, durable, readily available at the source, and difficult or impossible to find at the point of exchange. *Bufo alvarius* venom meets all requirements.

One *B. alvarius* toad yields 0.25 to 0.5 g of dried venom. Since concentrations of 5-MeO-DMT may be as high as 15%, one toad may yield 75 mg of a hallucinogenic drug that, when smoked, is effective in humans at doses of 3 to 5 mg. In other words, a single toad produces 12–25 doses of one of the most potent psychoactive drugs found in nature. A container the size of a matchbox could hold thousands of effective doses.

In the absence of solid ethnohistoric and ethnographic data, the suggestion that the ancient peoples of Mesoamerica may have used *B. alvarius* as a hallucinogen remains purely speculative. However, based on solid chemical and pharmacological evidence, we can be quite certain that they did not use *B. marinus*, at least not in any manner consistent with what we know of the contemporary use of psychotomimetics by indigenous societies of the Americas. *Bufo marinus* venom may have been employed as an ordeal poison and the physiological effects caused by its action on the cardiovascular system may conceivably have been interpreted in culturally meaningful ways by religious practitioners. But it was not a hallucinogen.

This conclusion aside, there is still the puzzling issue of the distribution of *B. marinus* bones at various Maya sites. While Cooke (1979, 1981) is no doubt correct in suggesting that *B. marinus* was consumed as food, the fact remains that the toad is often found in ritual contexts. At Seibal, Stanley Olsen (1978) found a partially intact *B. marinus* skeleton inside a Late Classic burial vessel. A *B. marinus* skull turned up in a Classic burial at Dzibilchaltun (Wing and Steadman 1980). At Mayapan, the skeleton and skull of a single specimen of *B. marinus* was found in a sealed chamber containing two human burials (Pollock and Ray 1957). Elizabeth Wing reports finding a *chultun* at the early Maya site of Cuello in Belize that contained relatively few reptile remains, but an unexpectedly high concentration of *B. marinus* bones (Wing and Scudder 1991). At San Lorenzo, Coe (1971) also noted the unusual amount and distribution of *B. marinus* remains. At Cozumel, Hamblin (1984) found that *B. marinus* bones made up as much as 99% of the amphibian component and the overwhelming majority of the material was excavated from ceremonial contexts, primarily from the Late Postclassic. While some of these instances may represent intrusions, and it is possible that toads were left as ceremonial food offerings, both the number and the synchronic and diachronic distribution of these *B. marinus* remains suggests that there is a pattern of toads being placed in ritual burials (Hamblin 1984).

Several explanations are plausible. The most obvious is that the toads were ritual offerings, not because they were hallucinogenic but due to a wealth of powerful symbolic meanings. The toad as the Great Earth Mother, as an image of transformation, death and regeneration, harbinger of the seasonal rains and protector of crops is a potent mythic complex found throughout the Americas (Wassén 1934). In Aztec cosmology the toad is Tlaltecuhti, the mediator, the image of fecundity and cannibalism, at once creator and destroyer of life (Furst 1976). In Maya religion toads or frogs are the attendants and musicians of the Chacs, the Yucatec rain gods (Hamblin 1984). Representations that could be either toads or frogs appear with some frequency in the Maya Codices (Tozzer and Allen 1910). Given these mythological and religious associations, it should not be surprising that *B. marinus*, the largest and most conspicuous toad in Mesoamerica, is found in ancient Maya burials.

There is one other intriguing possibility worth considering. Both *B. marinus* and *B. alvarius* are enormous toads, readily distinguished from many other species of the genus simply because of their size. In studying the osteological remains from the various Mayan sites, archaeologists would have no difficulty separating *B. marinus* bones from the remains of the other much smaller toads native to the region (Zug, personal communication 1991). There would be no particular reason to consider *B. alvarius*, an obscure species endemic to a completely different habitat several hundred miles away. As Wing, who identified the amphibian remains at San Lorenzo, notes in a recent letter, "I am sure that *B. alvarius* was not considered a possibility in the identifications I made from material in Vera Cruz and Belize. I am sure I looked just at the regional species and the large size of *B. marinus* separated it easily" (Wing, personal communication 1991).

Is it possible that some of the toad remains found in ritual context and identified as *Bufo marinus* may, in fact, be *Bufo alvarius*? After comparing the one large specimen of *B. alvarius* in the collections at the Florida Museum of Natural History, Wing states,

> The results of a quick look at whether skeletal remains of *B. marinus* and *B. alvarius* can be easily distinguished is inconclusive. . . . It (*B. alvarius*) is separable from all our marinus specimens with respect to the relative size of the dorsal projection on the blade of the illium though this is a variable character and what I do not know is whether our alvarius specimen is just on the large end of the continuum. . . . This issue of the possible introduction of alvarius into Mexico and south needs to be closely examined but more comparative material than I have at the moment is necessary to do this. (Wing, personal communication 1991)

Clearly, in the absence of strong supporting evidence from the ethnographic and ethnohistoric record, it is premature to conclude that the ancient peoples of Mesoamerica employed *B. alvarius* as a sacred intoxicant. However, having proved beyond doubt that a psychoactive toad does, in fact, exist and was available in Precolumbian America, we invite others more knowledgeable in the discipline to reexamine the archaeological and iconographic record with this revelation in mind. In particular, we would encourage a careful review of the osteological remains in order to determine whether *B. alvarius* has not, in fact, already been found at various Mayan sites.

RESUMEN

Los antropólogos han especulado que durante mucho tiempo la antigua gente de Mesoamérica utilizaba un tipo de sapo, *Bufo marinus*, como un intoxicante ritual. Esta hipótesis se basa en representaciones iconográficas y mitológicas de sapos y en un número de reportes etnográficos especulativos. Los autores rechazen *B. marinus* como un candidato para tal uso por la toxicidad de su veneno. Un candidato más probable es el

sapo del desierto Sonoran, *Bufo alvarius*, que segrega una gran cantidad de una potente sustencia alucinógena conocido como, 5-methoxy-N,N-dimethyltryptamina (5-MeO-DMT). Los autores demuestran que el veneno de *B. alvarius*, aunque se conoce como una toxina poderosa cuando es consumido oralmente, puede ser fumado y es un psicodélico poderoso cuando es administrado de esta manera. Estos experimentos son la primera documentación de un agente alucinógeno derivado del mundo animal, y proveen evidencias claras de un sapo psicodélico que puede haber sido empleado por gente precolombiana del Nuevo Mundo.

ACKNOWLEDGMENTS

The authors would like to acknowledge the assistance of a number of individuals who provided data and shared insights that assisted us in preparing this paper: Bret Blosser, Dennis Cornejo, Bruce Dahlin, Peter Furst, Gunga Jolicoeur, Tim Knab, Sabine Kremp, Dennis McKenna, Al Morgan, Al Most, Gail Percy, White Dog, Johannes Wilbert, Elizabeth Wing, and George Zug.

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